South Dakota State University
Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange

Extension Extra

SDSU Extension

10-1-2004

Ensiling Immature and Frost Damaged Corn

Peter Jeranyama
South Dakota State University

Cody Wright
South Dakota State University

Kent Tjardes
South Dakota State University

COOPERATIVE EXTENSION SERVICE
SDSU

Extension Extra

ExEx8150
October 2004

COLLEGE OF AGRICULTURE & BIOLOGICAL SCIENCES / SOUTH DAKOTA STATE UNIVERSITY / USDA

Ensiling Immature and Frost Damaged Corn

Peter Jeranyama, Extension forage crops specialist, Plant Science Department
Cody Wright, Extension beef specialist, Department of Animal and Range Sciences
Kent Tjardes, Extension beef feedlot specialist, Department of Animal and Range Sciences

Immature corn is corn that fails to reach adequate maturity and can not be sold at normal, prevailing market values without steep price discounts. Corn that is drought stressed, heat unit deficient, water logged, or frost damaged meets this definition.

Corn is uniquely suited to silage making. But when corn is damaged or killed by frost before it reaches the desired maturity for ensiling, the stage of maturity at the time of frost is very critical.

If frost is early and green leaves remain on plants it may be best to let the crop stand, as it will continue to accumulate dry matter, until the whole plant moisture content nears 63 to 68%. Partially frosted corn appears deceptively drier than unfrosted corn at the same moisture content. If plants are killed by frost at an immature stage they will contain higher moisture content than is recommended for ensiling. They will dry down very slowly.

However, if frost sets in close to silage harvest time, harvest the crop immediately. If the crop becomes too dry, consider a finer chop and adding water or wet forage during ensiling.

The optimum corn silage harvest stage for maximum energy yields is between 63 to 68% moisture content and at the 2/3-milk line maturity stage. The milk line can be viewed on the tip of a representative ear that has been broken in half.

However, the relationship between milk kernel line and whole plant moisture content is highly variable. Milk line should only be used as an indicator of when to start monitoring whole plant moisture content. The trigger for corn silage harvesting is the whole plant moisture content.

If corn is harvested at more than 70% whole plant moisture content, the result will be:

- lower dry matter yield per acre.
- increased seepage losses (nutrient loss).
- reduced dry matter intake, as silage has a sour taste and odor.
- lower milk production or reduced weight gains when fed.

If corn has less than 60% whole plant moisture,

- no dry matter yield benefit; yield most likely will be reduced 5-10% due to leaf loss.
- potential silage mold problems and mycotoxin levels increase as fermentation is hampered.
- dangerous levels of heat production.
- potential reduction in nutritive value due to heat damage, reduced starch digestion, and reduced fiber digestion.
- reduced milk production or weight gains.

Corn dries at an average rate of 0.5% of whole plant moisture content per day. Environmental conditions such as cool, wet weather can slow down rate of drying, while hot and dry days tend to accelerate drying rate. However, 0.5 % per day is a good rule-of-thumb for predicting when fields will be ready for chopping for the type of storage you plan to use.

Table 1. Recommended moisture contents for corn silage stored in various silos.

Type of silo	Recommended moisture content for ensiling, %
Horizontal bunker	65 to 70
Bag	60 to 70
Upright concrete stave	60 to 65
Upright oxygen limiting	50 to 60

Source: NCR574 (1995)

Estimating whole plant moisture content

Cut two to four representative corn plants from the field at silage cutting height, chop them into small pieces (e.g., with a brush chipper), and mix well in a 5-gallon bucket. On a paper plate weigh out exactly 100 grams of fresh silage, and adjust for the weight of the paper plate. Spread the silage evenly on the plate, place in microwave, and heat on high for 4 minutes. Remove, weigh, and record. Repeat procedure on high for 1 minute, and weigh and record. Repeat procedure until the weight of the sample remains constant. At this point, the weight is the dry matter (DM) of the silage. Calculate the moisture percentage by subtracting the dry matter weight from 100.

Stressed conditions

Under stressed conditions such as during a frost or drought, corn tends to accumulate higher levels of nitrate than normal. Producers generally have the option of cutting corn at various heights ranging from 6 to 18 inches. Determine cutting height by prioritizing your need for maximum crop yield or for high quality silage.

Cutting at 18" is associated with

- lower dry matter yield per acre.
- low concentrations of NDF, ADF, and lignin associated with better forage quality.
- increased estimated milk yield per ton of fed silage.
- a similar estimated milk yield per acre compared with a 6-inch cut.
- less soil erosion.
- lower silage nitrate levels.

Strategies to reduce corn silage moisture content

As a rule of thumb, 30 lb DM/ton of silage of the following materials, when they are at 100% dry matter content, will reduce moisture content by 1%:

- ground grain.
- chopped straw, but it may decrease fiber digestibility/energy.
- chopped hay, which may increase forage value.

When adding dry matter to silage, it is critical to mix it well and make sure the stack is well packed to ensure proper fermentation.

Silage additives

At times, ensiled forages lack sufficient populations of bacteria to support adequate fermentation. In some cases, levels of water soluble carbohydrates required for fermentation may be too low or wilting below 70% moisture may not be feasible. Silage additives—fermentation stimulants or inhibitors—can correct these situations.

There are four principal additives that can be used to improve the ensiling process or enhance bunk life: bacterial inoculants, non-protein nitrogen sources such as anhydrous ammonia, enzymes, and organic acids such as propionic acid. The choice of additive should be based on meeting a particular goal or solving a particular problem in ensiling as well as increasing profitability.

Bacterial inoculants improve overall fermentation or the production of lactic acid. Lactic acid is the most desirable organic acid in silage making as it is very effective in reducing pH to required levels and reducing ammonia production in most cases.

Unfortunately, these products do not always work particularly well in corn silage. Poor results appear to be due to higher natural levels of lactic acid bacteria or corn at ensiling. A recent survey showed that bacterial inoculants affected fermentation 40% of the time in corn silage in contrast to 75% in legume silage.

Other additives that provide readily fermentable carbohydrates, such as molasses, glucose, sucrose, and cereal grains, do not work very well with corn silage.

Anhydrous ammonia is commonly used in making corn silage primarily because it increases crude protein content of the silage and increases silage bunk life. Adding ammonia immediately raises crop pH, and this kills many yeasts, molds, and bacteria that cause heating and spoilage. Anhydrous ammonia raises the crude protein content by 5 percentage points.

The quantity of additive to apply depends on moisture content of the crop at ensiling. For example, 6.5 lb/ton anhydrous ammonia is needed if silage dry matter is 33%, while more (8.0 lb/ton anhydrous ammonia) is needed if silage dry matter is 40%. Take precautions when handling anhydrous ammonia.

Enzyme additives such as amylases, cellulases, and hemicellulases break down the structural and nonstructural carbohydrates and release fermentable sugars. These enzymes also improve forage quality by reducing the concentration of NDF and ADF. Enzymes work most effectively when moisture content is greater than 55%.

Overall, enzymes currently do not appear to be a useful additive for making corn silage. First, high fiber content is not usually a problem in corn silage. Second, if corn silage is made at the appropriate moisture content for enzymes, increased seepage losses are likely, especially in upright silos. Finally, there appears to be little opportunity for recovery of the additive's cost in corn silage.

Organic acids, such as propionic acid and mixtures of propionic acid with other organic acids, acetic acid, for example, are used to reduce spoilage and increase bunk life by inhibiting yeasts and molds. Propionic acid is a stronger inhibitor but is considerably more expensive than acetic acid. These products may be added at ensiling, typically at a rate of 0.2 to 1.0% of fresh weight. Do not apply these products at less than recommended rates as this reduces their effectiveness.

At times these additives are used when emptying a silo in a situation where the silage is heating in the silo and in the feed bunk. In such cases the product is sprayed on the silage face.

Estimating silage yield

The general method is to estimate grain yield of standing corn, then divide by 5 to obtain silage yield. For example, if grain yield =50 bu/ac then silage yield is 50/5 = 10 ton/ac.

This relationship changes somewhat as the yield increases; e.g. for 110 bu/ac corn, silage yield is 18 ton/ac; 150 bu/ac silage is 22 ton/ac. A relationship between grain and silage yield for current hybrids is described in Figure 1.

References

Lauer, J. 2000. Relationship between corn grain and silage yield. Field Crops 28:5-27.

NCR574. 1995. Corn silage production, management and feeding. ASA-CSSA-SSSA, Madison, WI.

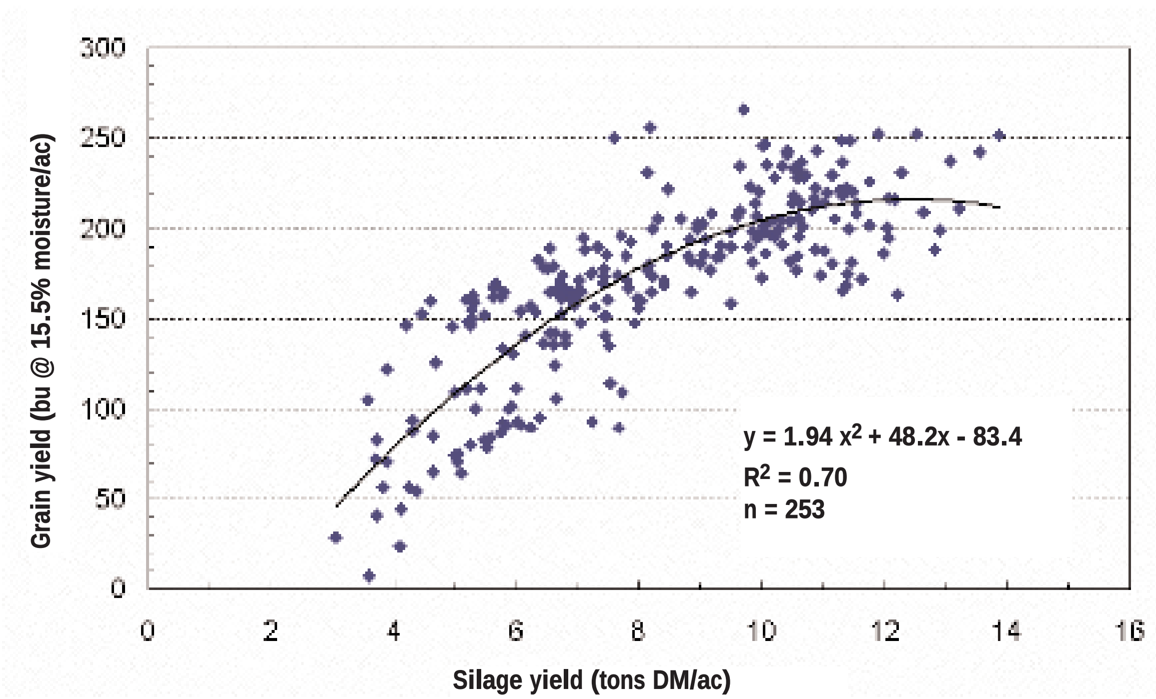

Figure 1. The relationship between corn grain yield and silage during 1997 and 1998 growing season in Wisconsin. Source: Joe Lauer (2000).

COOPERATIVE EXTENSION SERVICE SDSU

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the USDA. Gerald Warmann, Director of Extension, Associate Dean, College of Agriculture & Biological Sciences, South Dakota State University, Brookings. SDSU is an Affirmative Action/Equal Opportunity Employer (Male/Female) and offers all benefits, services, and educational and employment opportunities without regard for ancestry, age, race, citizenship, color, creed, religion, gender, disability, national origin, sexual preference, or Vietnam Era veteran status.

ExEx8150, 2004. Access at http://agbiopubs.sdstate.edu/articles/ExEx8150.pdf